Problem 1 (40 points)

Prob. 6.7 of Thomson

Problem 2 (40 points)

Prob. 6.10 of Thomson

Problem 3 (20 points)

Consider a nucleus with a spherically symmetric charge distribution $\rho(r)$, where
\[ \int \rho(r) d^3r = 1. \]
The form factor in electron scattering off nucleus can be expressed as
\[ F(q) = \int \rho(r) e^{-i\mathbf{q} \cdot \mathbf{r}} d^3r \]
a) show that
\[ F(q) = \frac{4\pi}{q} \int_0^\infty \rho(r) r \sin(qr) dr \]
b) show that
\[ F(q) = 1 - \frac{q^2 <r^2>}{6} + ..., \text{ where } <r^2> \text{ is the mean square charge radius} \]
\[ <r^2> = 4\pi \int_0^\infty \rho(r) r^4 dr. \]
c) Calculate $F(q)$ and $<r^2>$ for $\rho(r) = \rho_0 e^{-\alpha r}$
d) Calculate $F(q)$ and $<r^2>$ for $\rho(r) = \rho_0 e^{-\alpha r}/r$